City of Toronto
Crawford Lane LID Pilot

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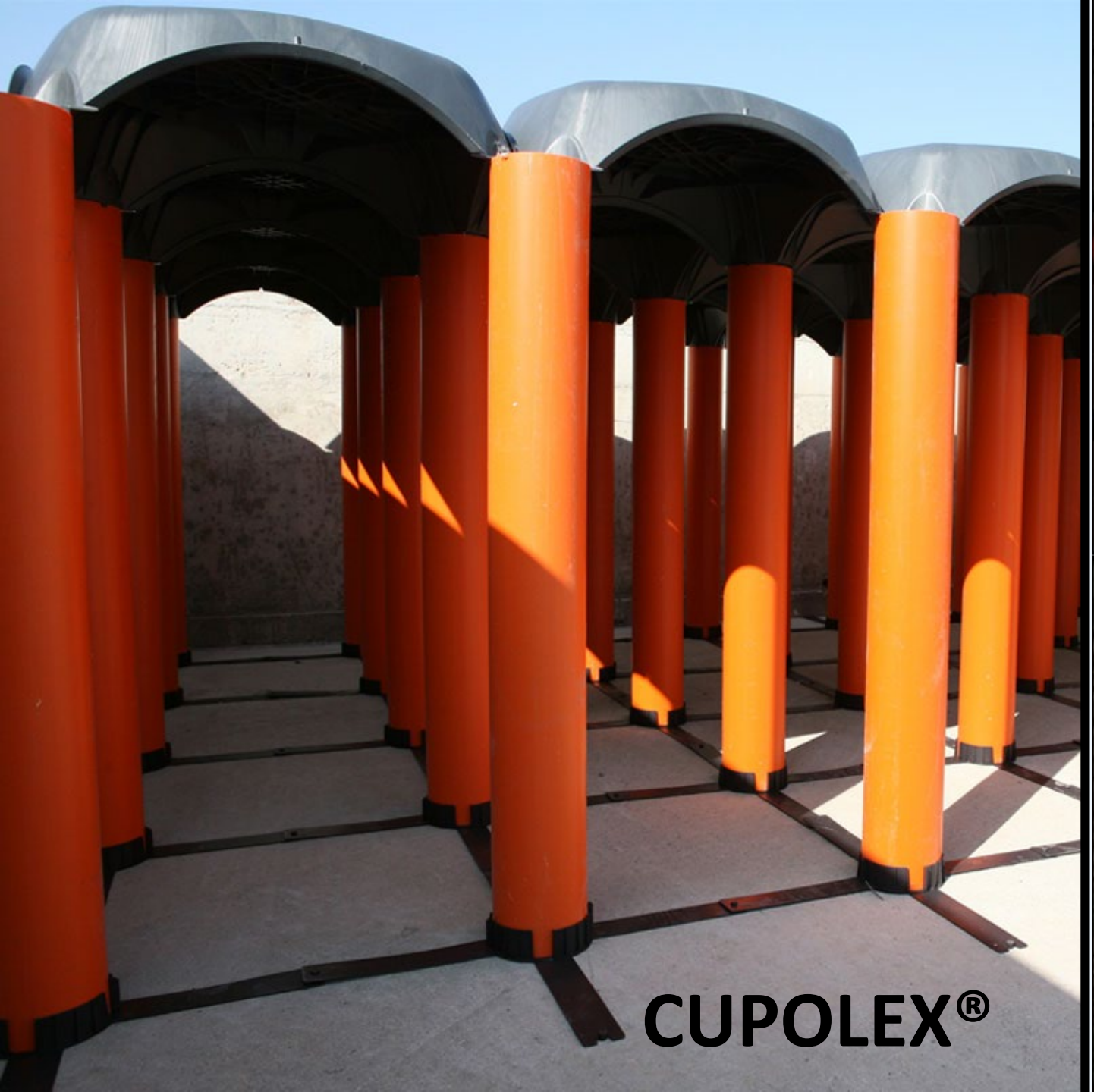
November 16, 2022
MEA Annual Conference: Chelsea Hotel, Toronto

Background

- Toronto is a fast-growing city in terms of infrastructural development and population growth.
- New urban development with transit expansion and climate change put more pressure on drainage systems resulting in frequent floods and environmental problems.
- Toronto's Green Streets Technical Guidelines (2017)
  - established new development standards within streets to promote Low Impact Development (also referred to as Green Infrastructure),
  - Reduce urban impacts on both quantity and quality of surface runoff, ecological systems, and air quality

The Challenge

- During heavy rain storms, storm sewers tend to over-flood during the storm peaks
- As part of Green Street Program, TS wanted to explore available technologies that can help mitigate such flooding
- Two technologies were identified for testing:
  - Underground Concrete Storage Systems (Cupolex®)
  - Porous Inter-locking Concrete Pavers (PICP)


CUPOLEX®

Porous Interlocking Concrete Pavers (PICP)

Laneway: The Determinants

- Testing facility needs to be ready for rehabilitation
- In case of failure, the test should cause the least cost of repair and disruption to laneway users
- The test has to be well designed as to reliably generate the required information

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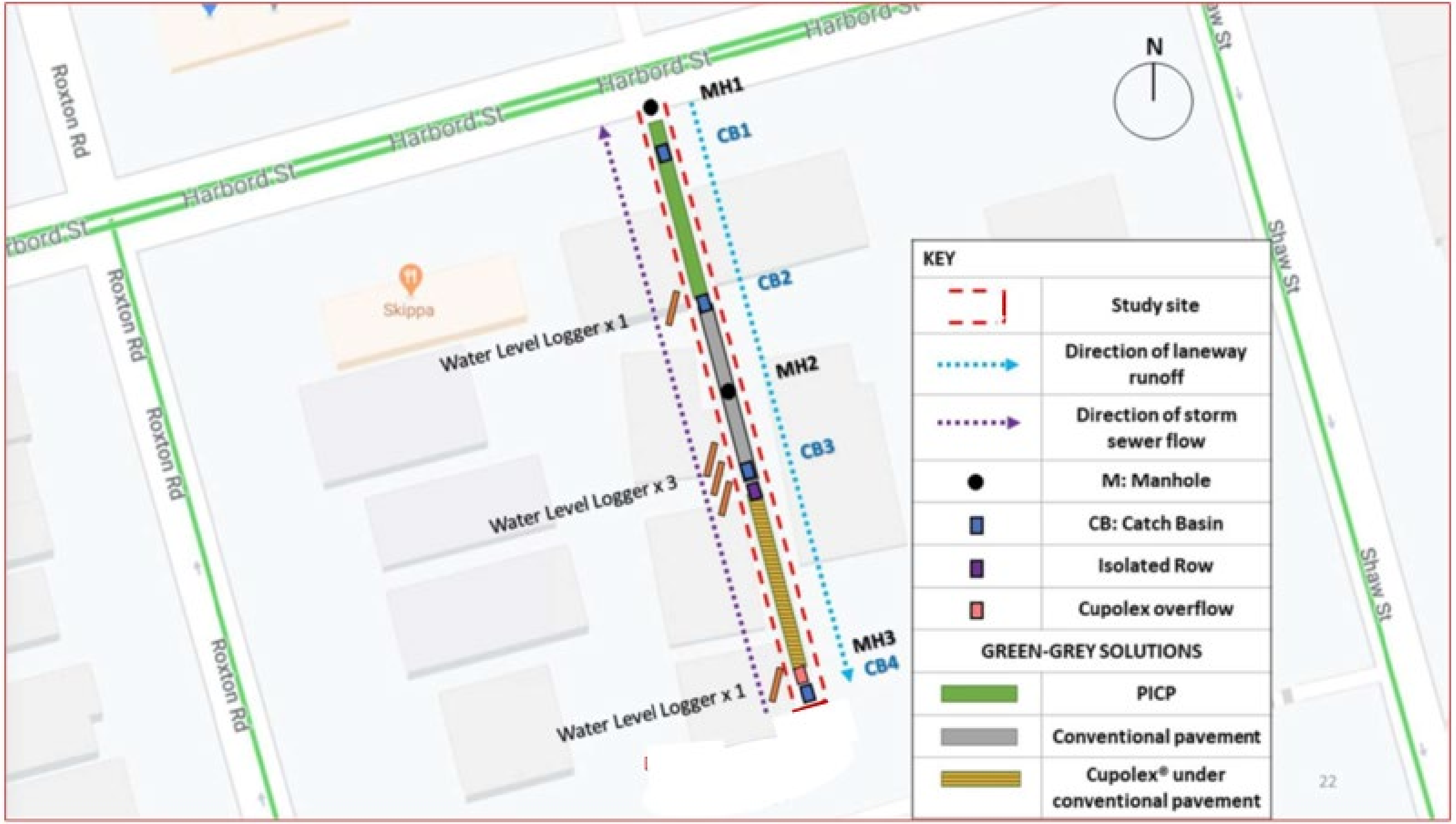
- Crawford Lane met the above determinants

The Pilot: Location and Layout

253 m long ➔ 3 sections, each about 84 m long

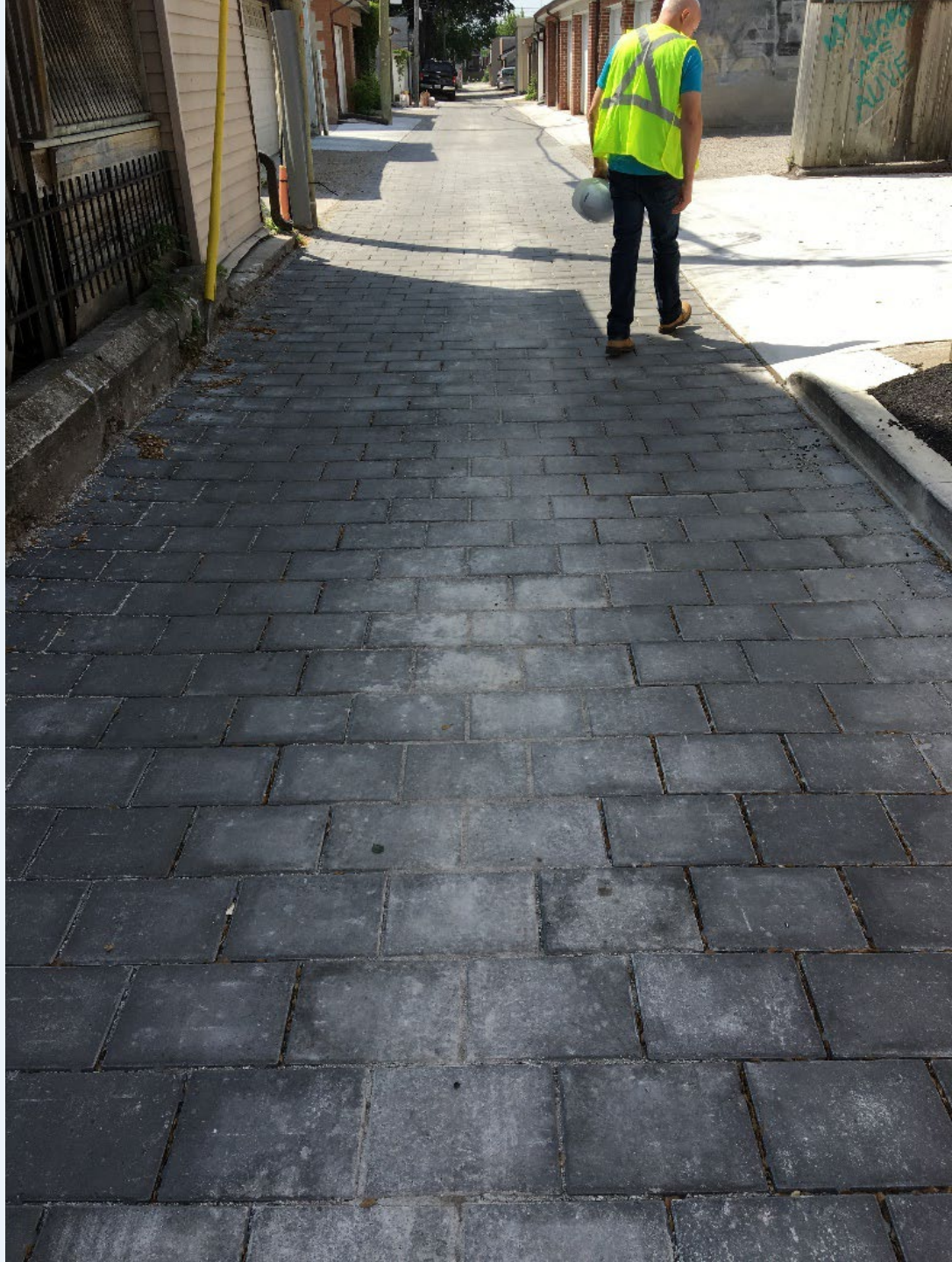
The Actors

- TS & ECS engineers
- Pontarolo Engineering (distributer of Cupolex)
- Toronto Metropolitan University (formerly Ryerson U)
- Burnside Engineering
- Dufferin Construction

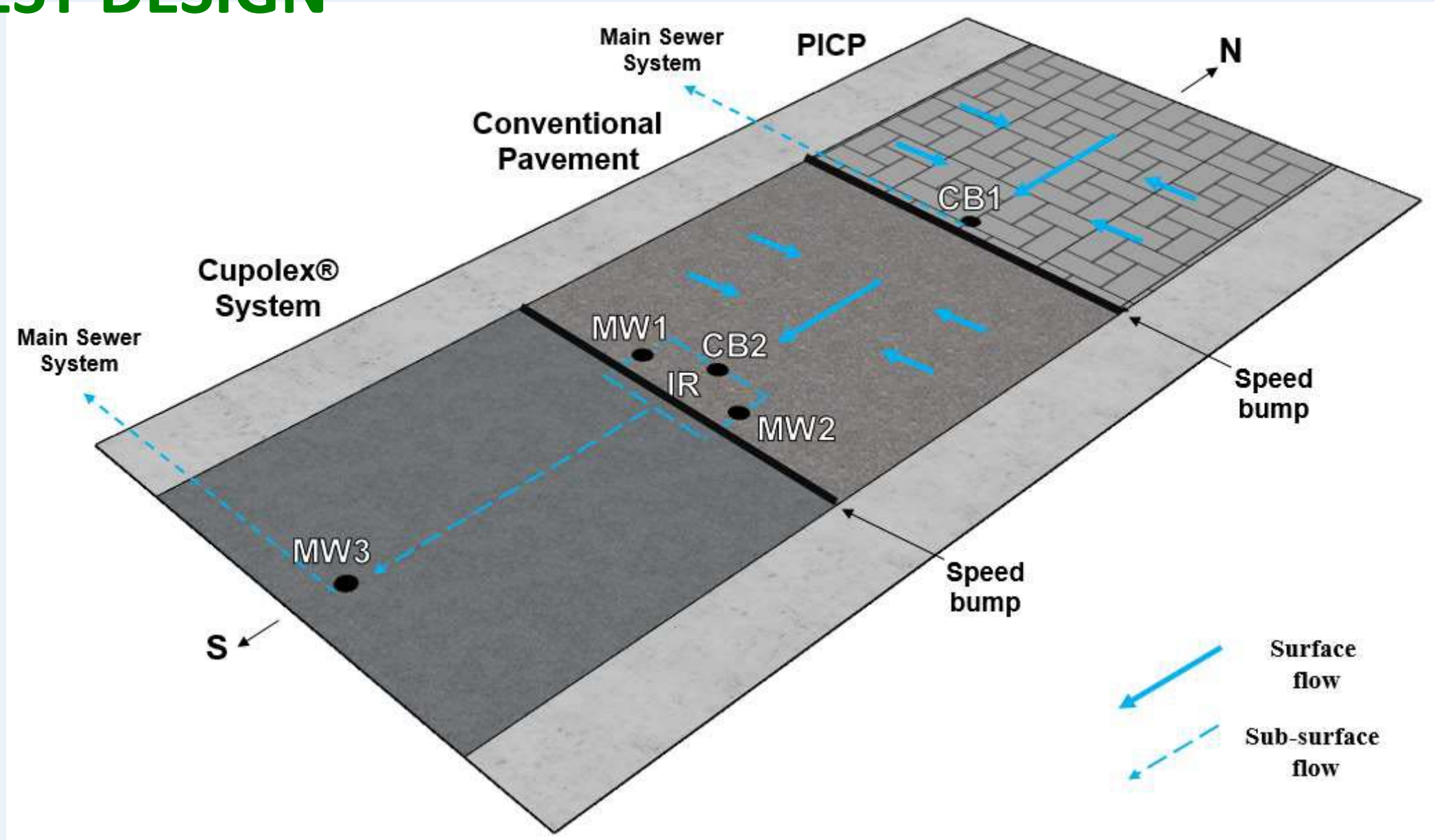

Harbord St
Roxton Rd
Shaw St
N
MH1
CB1
CB2
MH2
CB3
MH3
CB4
Water Level Logger x 1
Water Level Logger x 3
Water Level Logger x 1
Skippa
KEY
Study site
Direction of laneway runoff
Direction of storm sewer flow
M: Manhole
CB: Catch Basin
Isolated Row
Cupolex overflow
GREEN-GREY SOLUTIONS
PICP
Conventional pavement
Cupolex® under conventional pavement

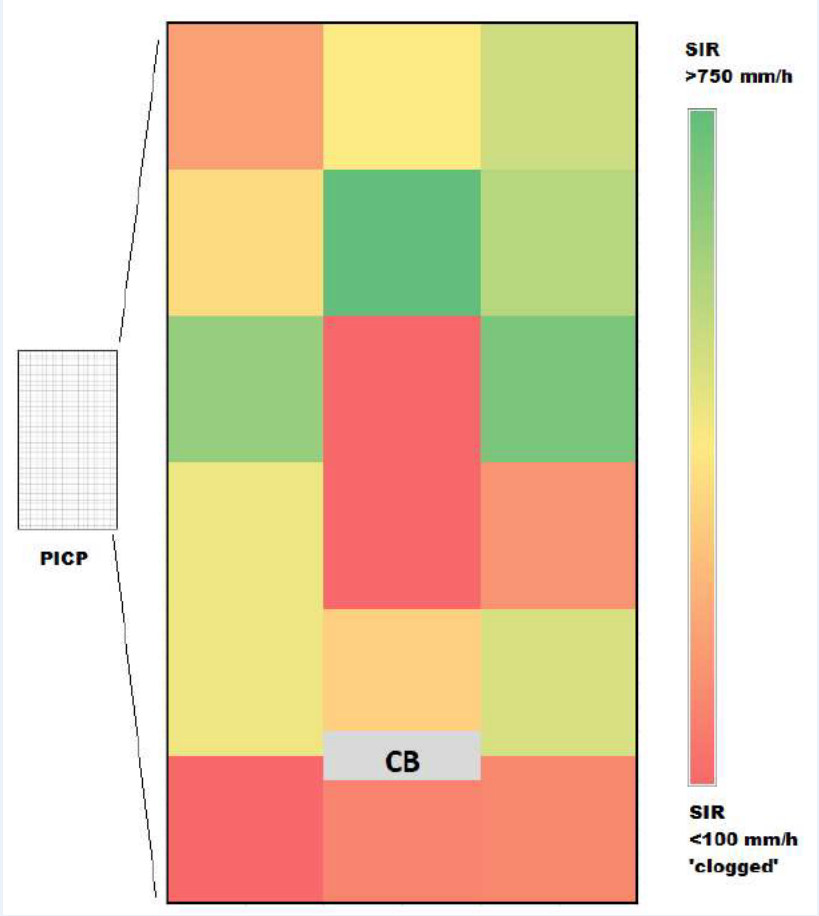
Crawford Lane Pilot

Looking South from Harbord St.



THE TEST DESIGN





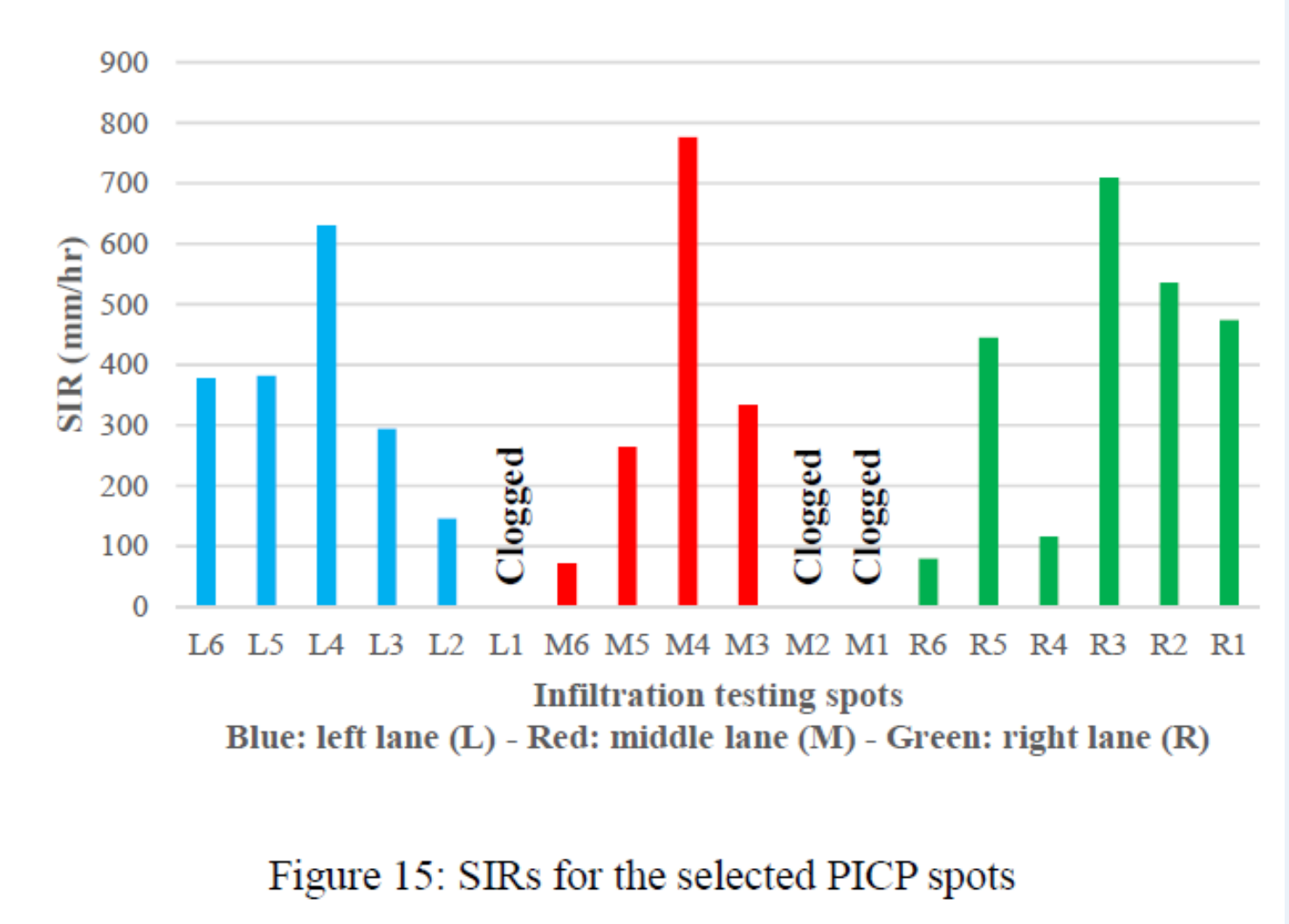
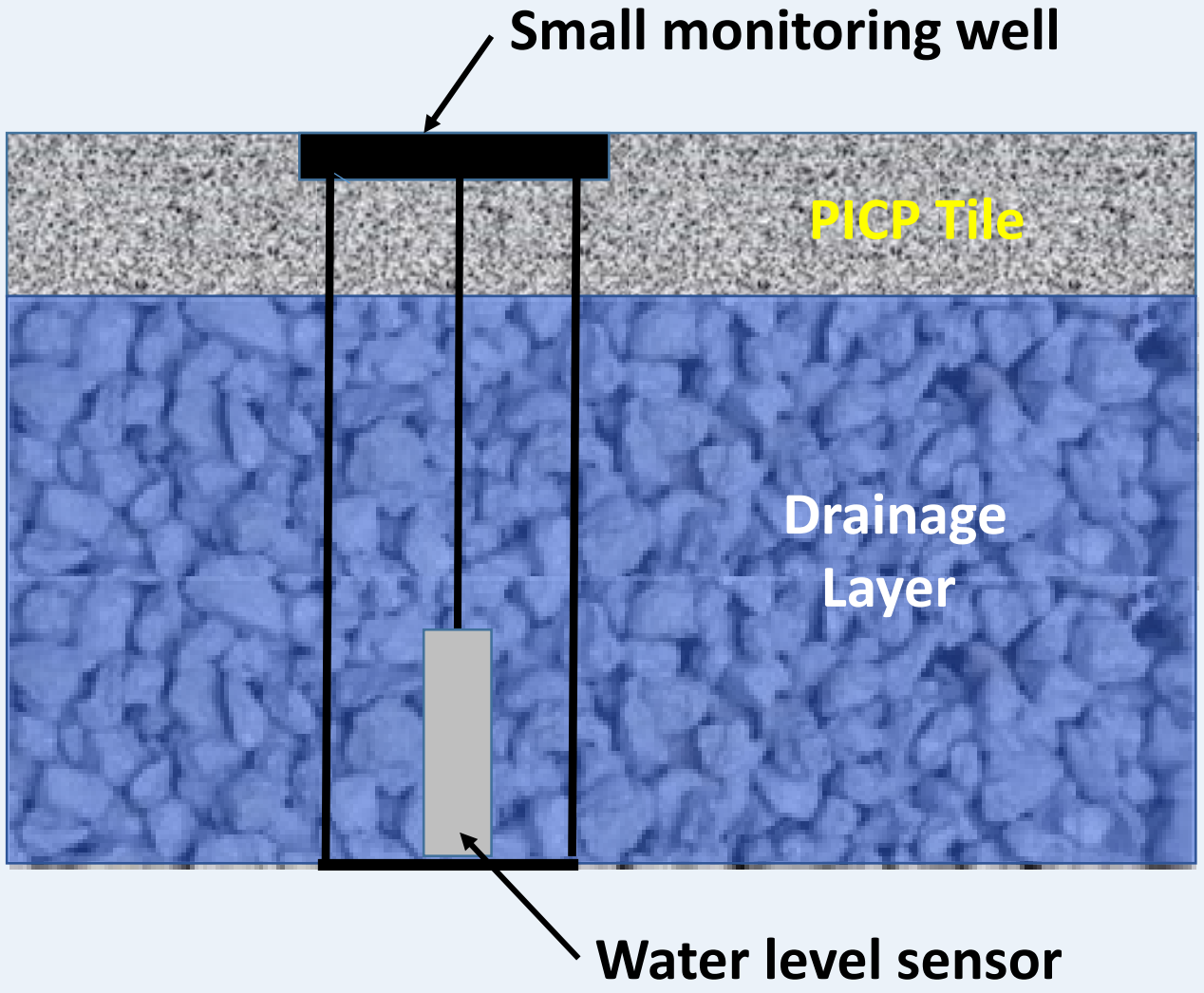


Figure 15: SIRs for the selected PICP spots

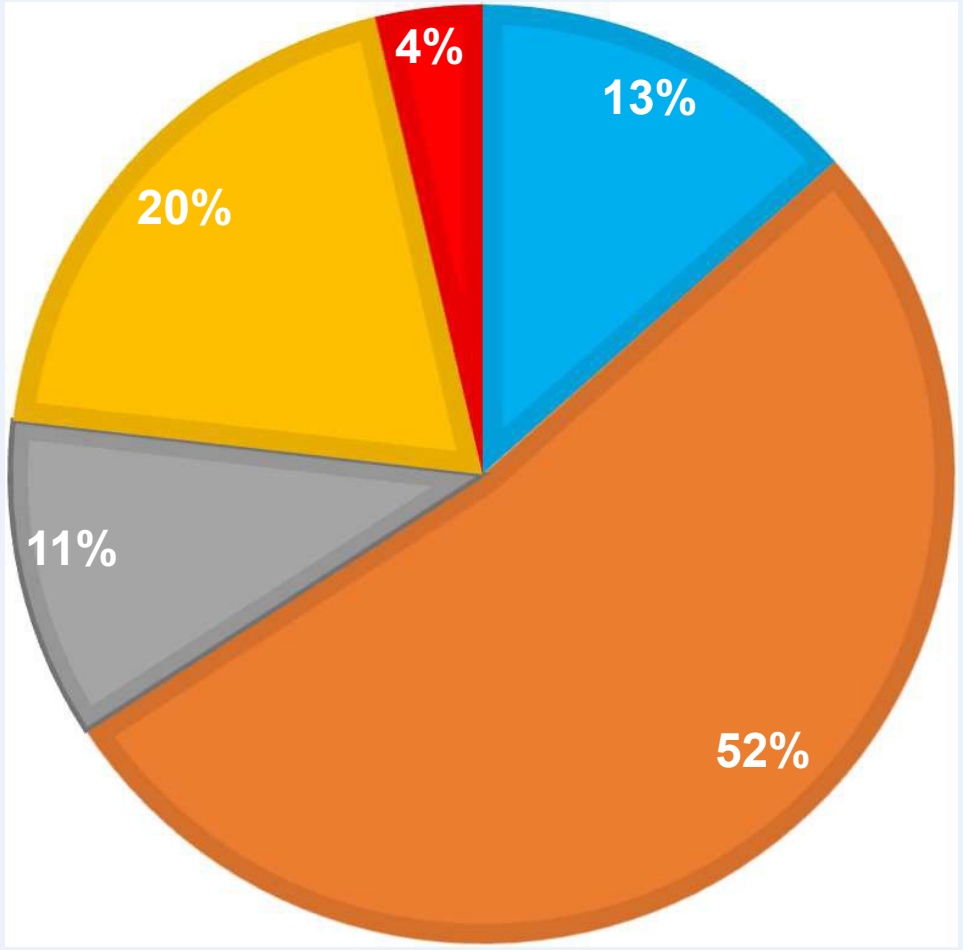
Measuring water infiltration through PICP



Sample Equipment Used in Monitoring

Date	**Start Time** (hh:mm)	**Duration** (min)	**Total Rainfall Depth** (mm)	**Average Rainfall Intensity** (mm/hr)	**5-min Peak Rainfall Intensity** (mm/hr)	**Antecedent Dry Period (ADP)** (d:hh:mm)
May 28, 2020	13:04	304	6.6	12.0	2.4	N/A
June 2, 2020	21:48	16	10	35.3	16.8	5:08:44
June 5, 2020	14:17	42	9.2	19.7	12.0	2:16:29
June 10, 2020	21:59	170	10.6	21.2	21.6	0:16:22
July 8, 2020	14:40	66	14	17.1	7.2	27:16:40
July 16, 2020	20:13	40	5	13.0	4.8	5:05:14
July 19, 2020	13:06	32	11.6	13.9	19.2	2:16:52
July 22, 2020	15:37	37	5	13.0	4.8	3:02:31
August 2, 2020	9:28	31	12.6	33.8	16.8	10:17:51
August 3, 2020	16:41	32	19.4	35.3	16.8	1:07:13
August 4, 2020	18:17	49	4.6	14.5	7.2	1:01:36
August 26, 2020	23:19	85	3.6	12.7	4.8	9:23:19

Classification of events based on rainfall depth



24% Major Storms

11% Medium

65% Light

October 26, 2021	00:17	913	8.2	12.0	2.4	0:23:41
October 29, 2021	17:37	379	7.4	12.0	2.4	4:17:20

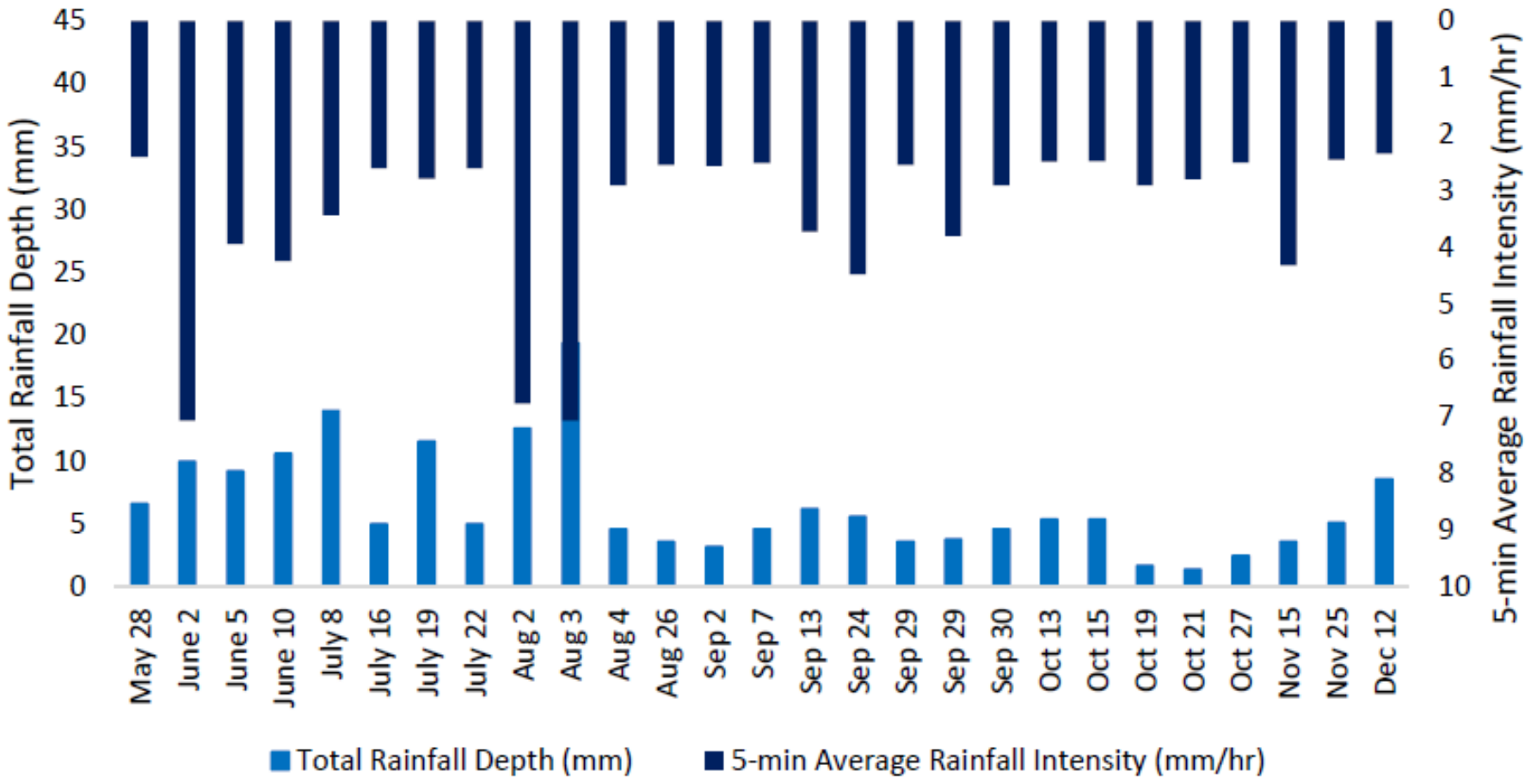


Figure 5: Total depth and 5-min average intensity for the recorded rainfall events in 2020

PICP

Over the monitoring period, field observations and inspections indicated the deteriorating surface conditions of the PICP.

- **The wash-off of the aggregates and**
- **The accumulation of sediments were observed**.

Ontario's CVC LID Manual (2018) recommends **routine maintenance tasks, including surface sweeping, at least once or twice a year.** Sweeping helps in preventing clogging, a major limitation for permeable pavements.

Cupolex Tiles → **Inaccessible**

↓

Isolating Row

↓

Sedimentation

↓

Measurements :
CB2 + Isolater Row MW 1&2
(Disk & Rod Method)

↙ ↓ ↘

April 15, 2022

MW 2	CB 2	MW 1
61.4mm	83.5mm	39.0mm

These depths represent the sediments accumulated after three years of construction.

Study Findings and Observations

- **The sizing of the Cupolex® is a crucial design element. While some design factors are easily determined (e.g., historical rainfall records), others could be relatively tricky (e.g., contributing drainage areas)**
- **The outlet of the Cupolex® system should always be coupled with an emergency overflow. In shorter antecedent dry periods, inflows in the Cupolex may build up before getting a chance to infiltrate.**
- **For design purposes, Cupolex® can be considered an infiltration-based device, similar to other infiltration LID facilities. Therefore, an underdrain may be required if the native soil is highly impermeable.**
- **Maintenance needs are lower for Cupolex® than PICP, whose surface is exposed to traffic and land-use conditions. However, the selection should also consider the life cycle costs for both systems.**
- **Cupolex® cells cannot be cleaned as they are embedded within the pavement. Thus, the isolator row is strongly recommended to allow for sediment settlement.**

Conclusions of the Analysis

- **Surface infiltration measurements at the PICP section revealed a median infiltration rate of 336 mm/hr, 168 mm/hr, and 459 mm/hr for the left, middle, and right lanes.**
- **The tests indicated that the PICP was still operating after two years of construction,**
- **Although the infiltration rates were lower than the recommended standards. It is concluded that Cupolex® is a more effective stormwater conveyance system to mitigate increased surface runoff than the PICP, especially when the native soil is relatively impermeable.**

Where do we go from here?

- From practice viewpoint, 3 important questions:
  1. Does the technology achieve the objective?
  2. Does it impact physical road performance?
  3. Is it cost-effective?
- Today, I reported on Q.1
- On Q.2, the Asset Management Unit has been taking surveys of the lane condition; short term – as seen, nothing serious was observed
- On Q.3, cost-effectiveness, we may have to do some different monitoring that will help us get a better profile of the LCC of these technologies

Thank You

for your interest in this topic
and for MEA's invitation!


QUESTIONS?
COMMENTS?
CONCERNS?